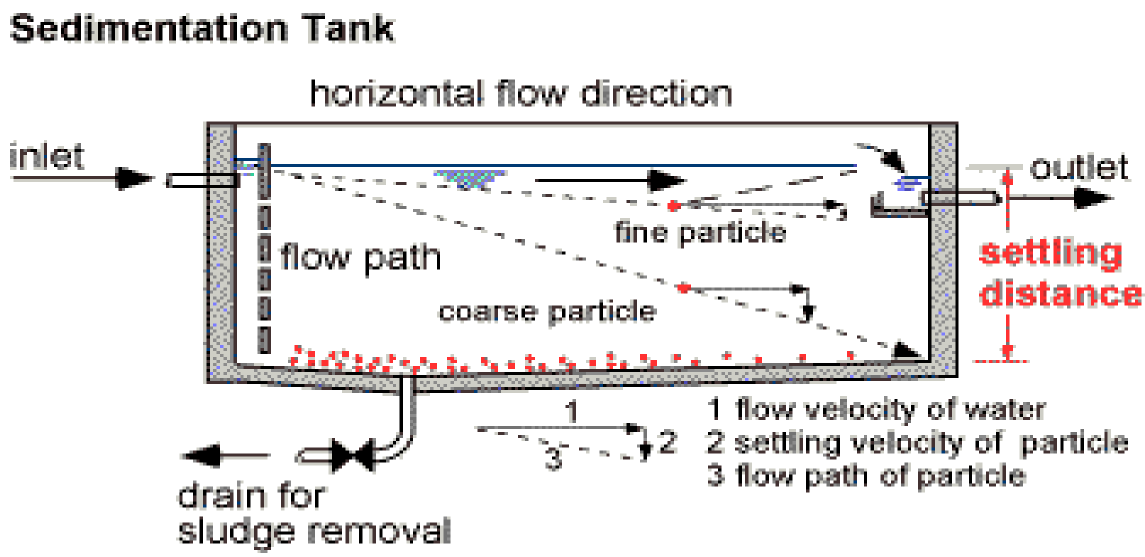
Sedimentation

Purpose:

Removal of 80% - 85% of suspended solids and colloidal matter. (In case of plane sedimentation)

Removal of 85% - 95% of suspended solids and colloidal matter. (in case of chemical sedimentation)



Factors effecting sedimentation:

1- Velocity of flow   Vh ≤ 0.3 m / min   (inversely prop.)
2- Viscosity   (inversely prop.)
3- Retention time   (directly prop.)
4- Temperature   (directly prop.)
5- Surface loading rate
6- Dimension of tank (prop. with L and inversely prop. With b)
7- Dead zones
8- Characteristics of particle
9- Sludge with drawl

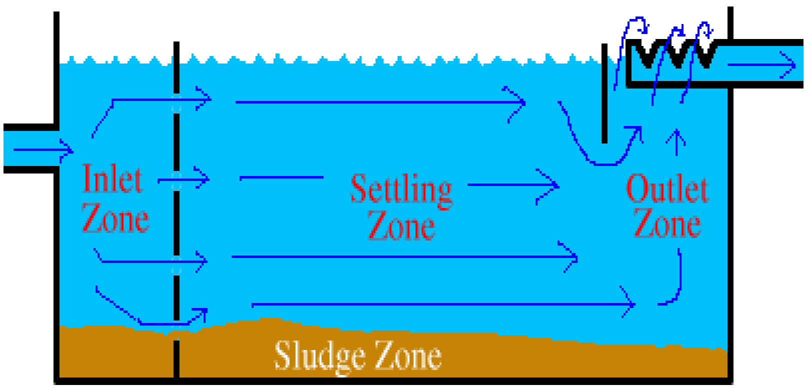
Types of sedimentation:

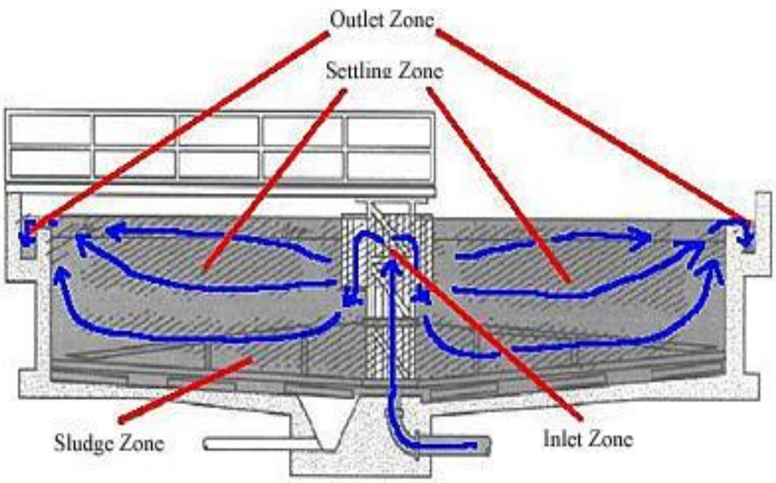
1- Plain sedimentation: without using any chemical substance and it is used in the slow sand filter water treatment plant.
2- Chemical sedimentation: using coagulant and it is used in rapid sand filter water treatment plant.

Types of sedimentation tanks:

1- Rectangular sedimentation tank. (Horizontal flow type)

2- Circular sedimentation tank. (Radial flow type)





Design criteria:

1- Qd = Qmax monthly x 1.1

2- T = 2 - 3 hrs

3- Depth = 3 - 5 m

4- Hydraulic weir loading = 300 $m^3/m^2/day$

5- Surface loading rate = (20 - 45) $m^3/m^2/day$

6- Horizontal velocity = Q / (n x b x d) $\leq$ 0.3 m/min

7- No. of tanks $\geq$ 2

8- Rectangular tank: L = (3 - 5) b $\therefore$ (b = L/4)

L $\leq$ 50 m

b = (2 - 4) d

9- Maximum diameter of circular tank ≤ 40 m
10- Sludge pipe Φ not < 150 mm

A photograph of circular sedimentation tank

Example:

For a water treatment plant of hourly out put 2400 m^3. Determine the number and dimensions of required sedimentation tanks.

Solution:

$$V = Q_d \times T$$

$$V = 2400 \times 1.1 \times 2.5 = 6600 m^3$$

$$S.L.R = 30 m^3 / m^2 / d$$

$$S.L.R = \frac{Q_d}{S.A}$$

$$S.A = \frac{Q_d}{S.L.R} = \frac{2640}{\frac{30}{24}} = 2112 m^2$$

$$d = \frac{V}{S.A} = \frac{6600}{2112} = 3.125 m \qquad (3-5m)$$

$$S.A = n(L \times b)$$

$$S.A = n(L \times \frac{L}{4})$$

$$2112 = n(\frac{L^2}{4}) \qquad assume\, n = 4$$

$$\therefore L = 45.96 \approx 46 m$$

$$b = \frac{L}{4} = \frac{46}{4} = 11.49 m$$

Check:

$$Horizontal\,velocity = \frac{Q_d}{n \times b \times d}$$

$$= \frac{\frac{2640}{60}}{4 \times 11.49 \times 3.125} = 0.3\, m/\min \quad safe$$

$$Effluent\; weir\; loading = \frac{Q_d}{n \times b}$$

$$= \frac{2640 \times 24}{4 \times 11.49} = 1378.59 m^3/m/d$$

$$Length\; of\;\; weir = \frac{Q_d}{n \times 300} = \frac{2640 \times 24}{4 \times 300} = 52.8\; m$$

Clarifloculator tanks

Purpose:

Flocculation and sedimentation.

Removal of 85 - 96 % of the suspended and colloidal matters

Design criteria:

T1 = 30 min (for flocculation), T2 = 2.5 hrs (for sedimentation)

For outer chamber

To = T1 + T2 = 3 hrs

do = (3 - 5) m

Φo ≤ 40 m

V ≤ 0.3 m/min

S.L.R. = Qd / n (S.Ao – S.Ai) → (20 - 45) m^3/m^2/day

Hydraulic weir loading = 300 m^3/m/day

For inner chamber

Ti = T1 = 30 min

di = do - 1 m

Φi = (½ - 1/3) Φo

Vi ≥ 0.3 m/sec

Clarifloculator tank

Example:

Design Clarifloculator tanks in water treatment plant of daily out put 48000 m3 and working hours 16 hrs per day.

Solution:

$$Q_d = \frac{48000 \times 1.1}{16} = 3300 m^3 / hr$$

For outer chamber

$V_o = Q_d \times T_o$ ($T_o = 0.5 + 2.5$)

$= 3300 \times 3 = 9900\ m^3$

$d_o = (3 - 5)$ m take $d_o = 4$m

$$A_o = \frac{V}{d_o} = \frac{9900}{4} = 2475 m^2$$

$$A_o = n \frac{\pi \phi_o^2}{4}$$

$$2475 = 3 \frac{\pi \phi_o^2}{4} \rightarrow \phi_o = 32.41 m$$

For inner chamber

$V_i = Q_i \times T_i$ (T_i =0.5)

= 3300 x 0.5 = 1650 m3

$d_i = d_o$ - 1m

= 4 – 1 = 3 m

$$A_i = \frac{V}{d_i} = \frac{1650}{3} = 550 m^2$$

$$A_i = n\frac{\pi\phi_i^2}{4}$$

$$550 = 3\frac{\pi\phi_i^2}{4} \rightarrow \phi_i = 15.28\ m$$

Check:

$$S.L.R = \frac{Q_d}{n(\frac{\pi\phi_o^2}{4} - \frac{\pi\phi_i^2}{4})}$$

$$S.L.R = \frac{3300}{3(\frac{\pi 32.41^2}{4} - \frac{\pi 15.28^2}{4})} = 1.7 m^3 / m^2 / hr$$